

CONNECTICUT VALLEY FLOOD CONTROL



CORPS OF ENGINEERS, U.S. ARMY

PROVIDENCE DISTRICT

PROVIDENCE, R.I.

407-362

/ CONNECTICUT RIVER
FLOOD CONTROL PROJECT /

U. S. ENGINEER OFFICE
PROVIDENCE, R. I.

The Connecticut River Basin extends from northern New Hampshire and the Province of Quebec to Long Island Sound. The eastern limits of the watershed lie in the White Mountains, in New Hampshire. The western divide of the watershed lies largely in the Green Mountains of Vermont and the Berkshire Hills in Massachusetts. The greatest length of the basin is about 280 miles and its greatest width about 62 miles. The total drainage area is 11,260 square miles, distributed as follows:

Canada	115 square miles
New Hampshire	3,096 " "
Vermont	3,911 " "
Massachusetts	2,712 " "
Connecticut	1,426 " "

TABLE I

TRIBUTARIES, CONNECTICUT RIVER

Stream	State	Enters		Drainage Area	
		Connecticut River:		in Square Miles	
		At Mile	Left or Right	Tribu- tary	Connecticut River above Confluence
Nulhegan.....	Vt.	344.5	Right	151	651
Upper Ammonoosuc....	N. H.	324.7	Left	260	945
Israel.....	N. H.	312.0	Left	130	1,266
Passumpsic.....	Vt.	279.4	Right	507	1,651
Ammonoosuc.....	N. H.	266.2	Left	402	2,227
Wells.....	Vt.	265.9	Right	99	2,629
Waits.....	Vt.	246.8	Right	146	2,866
Ompompanoosuc.....	Vt.	224.3	Right	136	3,155
White.....	Vt.	215.2	Right	710	3,358
Mascoma.....	N. H.	214.2	Left	195	4,068
Ottawaquechee.....	Vt.	210.2	Right	223	4,302
Sugar.....	N. H.	195.3	Left	274	4,674
Black.....	Vt.	183.1	Right	197	5,034
Williams.....	Vt.	176.4	Right	117	5,263
West.....	Vt.	149.2	Right	423	5,744
Ashuelot.....	N. H.	139.8	Left	420	6,247
Millers.....	Mass.	126.0	Left	390	6,741
Deerfield.....	Mass.	119.1	Right	665	7,174
Chicopee.....	Mass.	80.4	Left	724	8,303
Westfield.....	Mass.	75.0	Right	520	9,075
Scantic.....	Conn.	59.5	Left	113	9,716
Farmington.....	Conn.	57.1	Right	613	9,835
Salmon.....	Conn.	17.8	Left	152	10,927

The average annual precipitation in the Connecticut River Basin is fairly well established by records from 14 stations and over periods of observation of approximately 34 years. The average annual rainfall varies from about 45 inches in the southern portion to about 36 inches in the northern. In the vicinity of mountain peaks in Vermont and New Hampshire, however, the value may be as high as 60 inches for relatively small areas.

Records of run-off and stream flow have been established by the records of 46 United States Geological Survey gaging stations in the Connecticut Basin, of which 21 have been in operation for 20 years or longer. These data are also augmented by the records of municipal, utility, and private agencies.

While records of past floods in the Connecticut Basin extend back nearly 300 years, complete hydrological data are available for comparatively recent floods only. Fairly good records have been kept for the last 100 years and form a reliable basis for determining probable frequencies of recurrence. Older historical records state but vaguely the magnitude of the floods.

In November 1927 an unusually severe flood occurred which caused damages estimated at about \$15,000,000, mostly along tributary streams in Vermont. The rainfall from November 2 to November 4 in Vermont exceeded all previous records and swelled the tributary streams in this area to unprecedented proportions. The excessively large run-off, about 60 per cent, resulted from the ground being well saturated from a series of preceding minor rainfalls, in themselves somewhat in excess of normal.

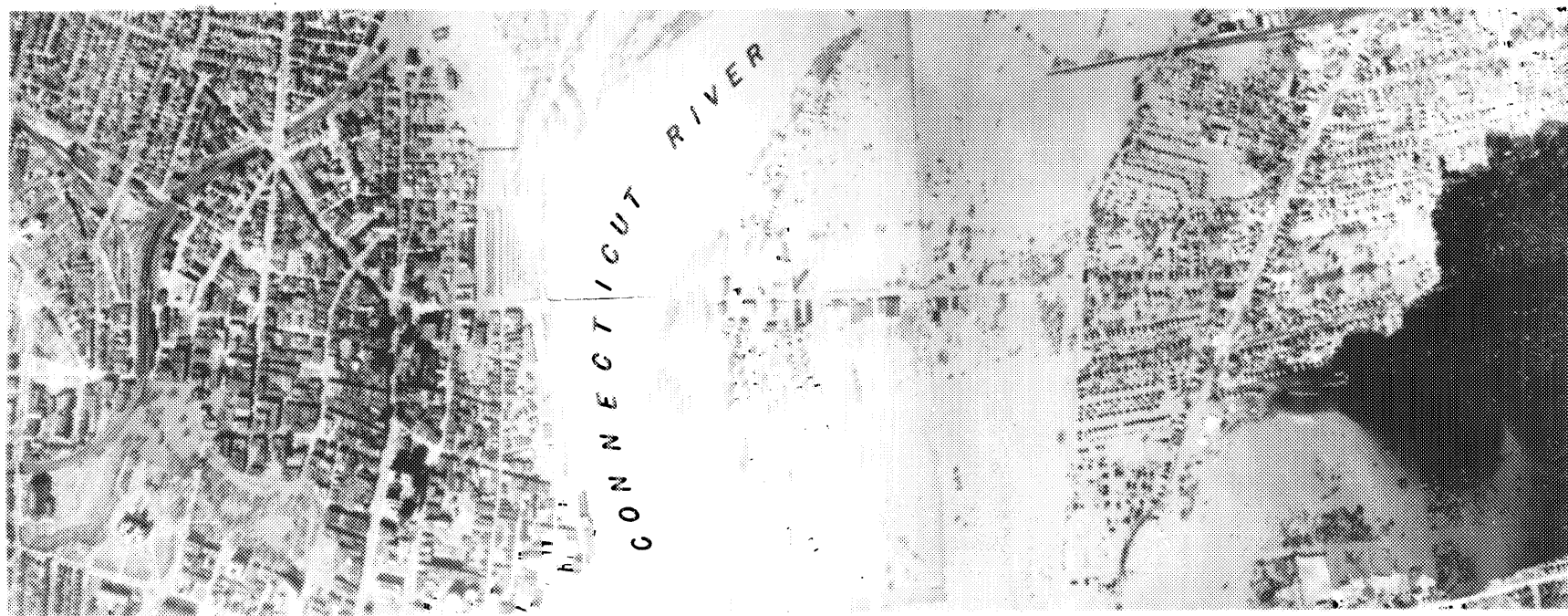
The flood of March 1936 was by far the largest flood of record on the lower part of the Connecticut Basin. It was caused by a long, continuous, warm rain falling on a snow cover of from 10 to 40 inches and accompanied by an increase in temperature. In addition, the rainfall on the southern part of the basin started two days later than on the northern part, bringing relatively higher discharges from the lower tributaries into coincidence with the flood crest in the lower Connecticut River itself. Connecticut River floods of major proportions had previously resulted from excessive rainfall alone, or from run-off from melting ice and snow alone. In 1936 the great flood resulted from a combination of the two.

The direct losses in 1927 and 1936 are estimated as \$15,526,000 and \$34,500,000 respectively. Of the 1936 losses, 93.5 per cent have been classified as "recurring" losses, which can be reduced or eliminated by proper flood control measures. Indirect losses are highest in urban and industrial regions (114 per cent of direct losses) and lowest in rural areas (10 per cent of direct losses), and have a total value throughout the basin of 94.5 per cent of the direct recurring losses. The 1936 flood caused an estimated depreciation of property values of \$74,857,000 in the area which will be protected by the Comprehensive Plan.

Average annual direct flood losses, determined from a mathematical solution of flood frequencies and estimated flood losses by zones at various stages, are put at about \$1,280,000. Annual indirect flood losses are estimated to be in the neighborhood of \$1,219,000. Annual losses from depreciation of property

HARTFORD

EAST HARTFORD



HARTFORD, CONN. — MARCH 20, 1936

The normal channel of the Connecticut River is indicated by the bridges in the left half of the picture. The flooded area on the extreme right is due to back-water in the Hockanum River.



SPRINGFIELD, MASS. — MARCH 20, 1936



DRAINAGE GATE IN CLARK DIKE, HARTFORD, CONN.
SHOWING RELATIVE HEIGHTS OF OLD AND NEW FILLS.

values, taken as the net annual loss of income as a result of the long term depreciation of values, amounted to about \$3,597,000. These figures indicate a total annual loss of about \$6,096,000 in the Connecticut River Basin chargeable to anticipated future floods in an inadequately protected valley.

DEFINITE PROJECT.

The area below Hartford, Conn., or south of the watershed of the Farmington River, amounting to about 812 square miles, was found after extensive hydrological studies to have a negligible effect upon the flood losses of the valley. It may therefore be disregarded. The area above Fifteen Mile Falls, amounting to 1,650 square miles, not only has a measure of control, owing to existing works, but also lies with respect to the valley below it so that it does not contribute appreciably to the major peaks. Therefore it may also be disregarded.

The critical area in which flood damages may be excessive is that bounding and tributary to the Connecticut River between Hartford, Conn., and Fifteen Mile Falls, about two hundred and twenty-five miles above Hartford, amounting in all to about 8,798 square miles. This is approximately 78 per cent of the entire Connecticut Basin. Of this flood-producing area private power interests and reservoirs for domestic water supply afford control, varying from partial to complete, for only 681 square miles, or less than 8 per cent of the total contributing area.

The present Definite Project was authorized by the Flood Control Act of 1936. This project is the initial step in providing adequate flood control for the critical drainage area. It provides for the construction of eight dams costing \$12,764,500 of which local interests are to pay \$2,484,000 for lands and damages. The eight sites selected and three alternate sites are shown in Table II.

TABLE II

DEFINITE PROJECT RESERVOIRS

Reservoir	Stream	State	D. A. : Sq. Mi.	Type of: Dam	Type of Spillway
Victory	:Moose (Passumpsic)	:Vt.	: 66.0	:Earth	:Side-hill
Tully	:Tully (Millers)	:Mass.	: 50.0	: do	:Saddle
Surry Mountain	:Ashuelot	:N. H.	: 100.0	: do	:Side-channel
N. Hartland	:Ottauquechee	:Vt.	: 221.0	: do	: do
Union Village	:Ompompanoosuc	: do	: 126.0	: do	:Saddle
Stocker Pond	:Sugar	:N. H.	: 35.4	: do	:Side-hill
Knightville	:Westfield	:Mass.	: 164.0	: do	:Saddle
Bethlehem Jct.	:Ammonoosuc	:N. H.	: 90.0	: do	:Side-channel

Reservoir	Stream	State	D. A. : :Sq. Mi.:	Type of: Dam	Type of Spillway
ALTERNATE SITES					
Priest Pond	Millers	Mass.:	19.0	Earth	Side-hill
Lower Naukeag	Millers	: do :	19.7	: do	: Overflow sec-
					: tion
Groton Pond	Wells	Vt. :	17.3	: Rock fill:	: Overflow sec-
				: and	: tion
				: concrete	

These dams will control a total drainage area of 853 square miles and have a combined capacity of 236,000 acre-feet. No funds have been provided for the construction of any of these dams.

Had they been constructed, the dams in the Definite Project would have had the effect given in Table III on flood heights in 1927 and 1936.

TABLE III

EFFECT OF DAMS IN REVISED DEFINITE PROJECT ON RIVER STAGE
REDUCTION

Station	River Stage Reduction in Feet	
	1927 Flood	1936 Flood
White River, Junction, Vt.	1.4	1.7
Bellows Falls, Vt.	3.9	2.8
Vernon, Vt. (Tailwater)	4.9	1.3
Montague City, Mass.	3.4	1.8
Holyoke, Mass.	1.7	0.6
Springfield, Mass.	2.5	1.7
Hartford, Conn.	2.8	2.1

A compact for the construction of flood control works was ratified by the four New England states of Massachusetts, Connecticut, Vermont, and New Hampshire. This compact included provisions for the immediate construction of three dams and reservoirs in Vermont, three in New Hampshire, and two in Massachusetts. Of the eight primary and three alternate dam sites included in the compact, all were included in the list of sites in the Definite Project, either as primary or alternate sites. This compact, in the form in which it was ratified, has not been considered acceptable to the Federal Government by Congress and further work on the project as a whole has been halted. At the present time the ultimate disposition of the plan is still uncertain.

An amendment to the Flood Control Act of 1936 provides that:

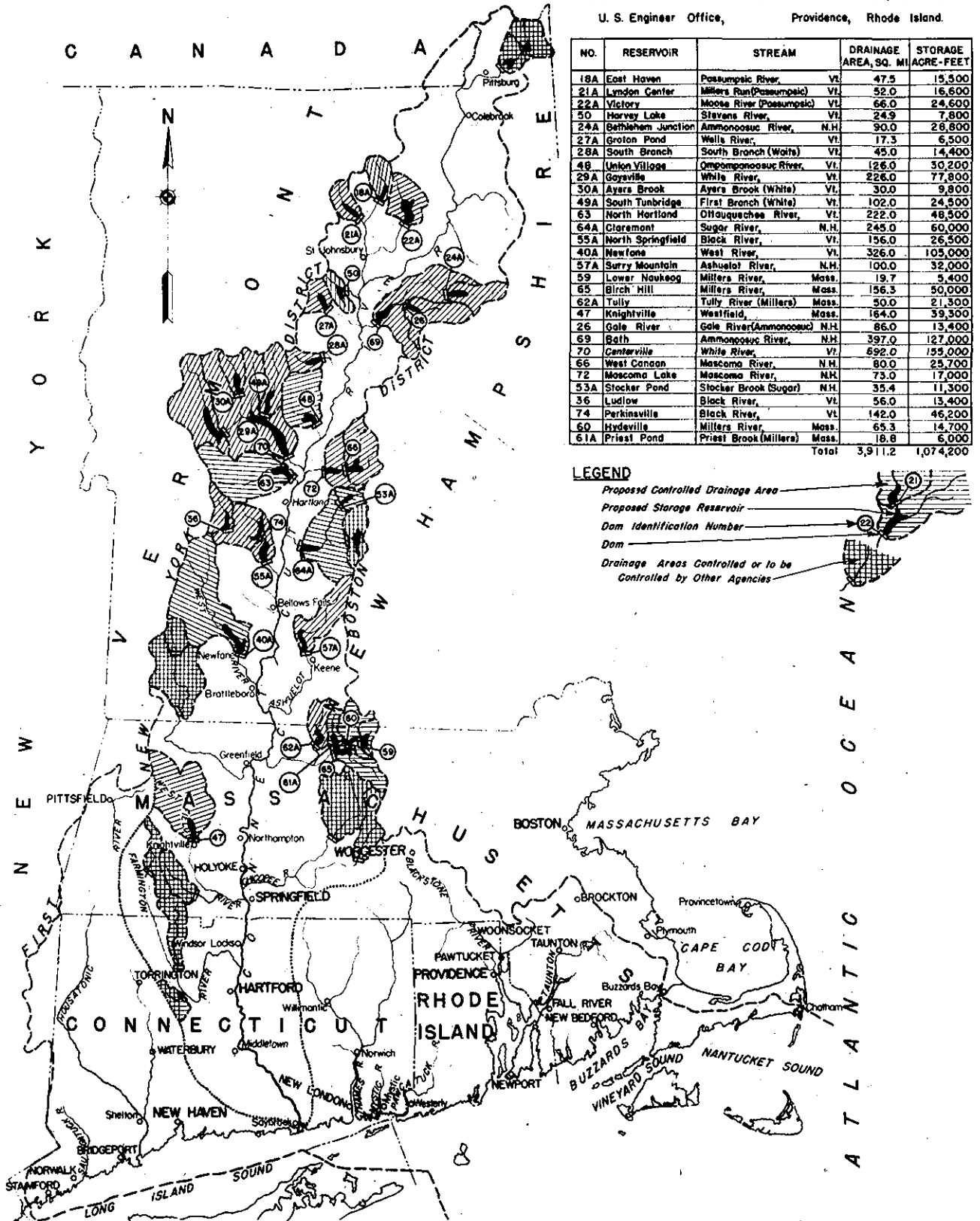
" * * * the plans for any reservoir project may, in the discretion of the Secretary of War, on recommendation

DISTRICT MAP

PROVIDENCE, R. I., DISTRICT

CONNECTICUT RIVER FLOOD CONTROL

U. S. Engineer Office, Providence, Rhode Island.



of the Chief of Engineers, be modified to provide additional storage capacity for domestic water supply or other conservation storage, on condition that the cost of such increased storage capacity is contributed by local agencies and that the local agencies agree to utilize such additional storage capacity in a manner consistent with Federal uses and purposes: * * *."

Under the foregoing provision enlarged reservoirs for multiple purposes may be built if the site permits and the additional cost is borne by local interests. Study of the sites has been made as to the feasibility of additional storage and its use for other purposes.

COMPREHENSIVE PLAN.

To provide for more complete flood control of the critical drainage area and to give needed local protection by dikes, additional studies of many reservoir sites and of congested areas in which high flood damages had occurred were made. The results of these studies were embodied in the Report of Survey and Comprehensive Plan dated March 20, 1937.

The Comprehensive Plan contemplates the construction of the eight dams included in the Definite Project and also the construction of twelve other dams. Seven more alternate sites are included. Table IV shows these sites.

TABLE IV

COMPREHENSIVE PLAN RESERVOIRS

Reservoir	Stream	State	D. A.	Type of	Type of
			Sq. Mi.	Dam	Spillway
N. Springfield	:Black	:Vt.	: 156.0	:Earth & concrete:	:Side-hill
Birch Hill	:Millers	:Mass.	: 156.3	:Earth	: do
Harvey Lake	:Stevens	:Vt.	: 25.0	: do	:Saddle
Lyndon Center	:Millers Run	:Vt.	: 52.0	: do	: do
	: (Passumpsic)	:	:	:	:
South Branch	:S. Branch (Waits)	:Vt.	: 45.0	: do	:Morning-glory
Gaysville	:White	:Vt.	: 226.0	:Concrete:	:Overflow
	:	:	:	: arch	: section
East Haven	:Passumpsic	:Vt.	: 47.5	:Earth	:Side-hill
Newfane	:West	:Vt.	: 326.0	: do	:Side-channel
Ayers Brook	:Ayers Brook (White)	:Vt.	: 30.0	: do	: do
S. Tunbridge	:First Branch(White)	:Vt.	: 102.0	: do	: do
Claremont	:Sugar	:N. H.	: 245.0	: do	: do

Reservoir	Stream	State	D. A. : Sq. Mi.	Type of : Dam	Type of : Spillway
ALTERNATE SITES					
Hydeville	Millers	Mass.	65.3	Earth	Overflow
					section
Mascoma Lake	Mascoma	N. H.	73.0	Earth &	Overflow
				concrete	section
Gale River	Gale River (Ammon-	N. H.	86.0	Rock	Side-channel
	oosuc)			fill	
Centerville	White	Vt.	692.0	Earth &	Overflow
				concrete	section
Perkinsville	Black	Vt.	142.0	Earth &	Overflow
				concrete	section
West Canaan	Mascoma	N. H.	80.0	Concrete	Overflow
					section
Ludlow	Black	Vt.	56.0	Earth	Side-channel
Bath	Ammonoosuc	N. H.	397.0	Earth	do

Dams listed above plus dams in Table II constitute the complete list of dams in the Comprehensive Plan. Groton Pond and Lower Naukeag, listed as alternate sites in the Definite Project Table II, are considered as primary dam sites of the Comprehensive Plan; while Stocker Pond, a primary site in the Definite Project, is an alternate site in the Comprehensive Plan.

The estimated cost of the twenty dams and reservoirs (eight in Definite Project and twelve additional) is \$34,835,000. Of this amount, \$10,575,000 is to be paid by local interests for lands and damages. The total effective flood storage capacity is 644,500 acre-feet and the drainage area controlled is 2,266 square miles, about 25.8 per cent of the total flood producing area of the Connecticut River.

It is estimated that had the Comprehensive Plan of flood control been in operation during the great floods of 1927 and 1936 the maximum stage of the river would have been reduced as shown in Table V.

TABLE V

Connecticut River Station	River Stage Reduction in Feet	
	1927 Flood	1936 Flood
White River, Junction, Vt.	9.8	4.5
Bellows Falls, Vt.	10.5	6.7
Vernon, Vt.	7.9	4.7
Montague City, Mass.	11.7	7.4
Holyoke, Mass.	5.6	2.7
Springfield, Mass.	6.5	4.8
Hartford, Conn.	7.0	4.8

In addition to the dams and reservoirs, whose principal purpose is to hold back excess flood waters in the upper regions of the watershed and along the tributaries, there is also contemplated the construction or augmentation of seven local protective systems of dikes and walls at Hartford, East Hartford, Springfield, West Springfield, Chicopee, Holyoke, and Northampton. The total estimated cost of the proposed dikes and walls is \$12,165,000. The amount payable by local interests is \$3,603,000.

Recommendation has been made that action on the additional reservoirs of the Comprehensive Plan be deferred. Construction or enlargement of the local protective systems at the seven localities mentioned has been recommended to the Congress, and the report is now before that body awaiting legislation authorizing and appropriating funds for construction.

Construction operations are now under way on local protective measures including dike and flood wall construction at Springfield and West Springfield, Mass., and Hartford, Conn. The work is being performed with funds allotted from the Emergency Relief Appropriation Act of 1937.

The work at West Springfield consists principally of the enlargement of an existing dike 6,100 linear feet long, just south of the Agawam Bridge along the Eastern States Exposition Grounds on the Westfield River. The completion of this work will protect the town of West Springfield against a flood of the magnitude of the 1936 flood.

The Springfield work consists of the construction of approximately 3,200 linear feet of earth dike and 1,000 feet of concrete flood wall along the Connecticut River between the North End Bridge and the Boston and Albany Railroad Bridge. The construction will give protection to that portion of Springfield north of the Boston and Albany Railroad against floods of the magnitude of that of 1936.

The project at Hartford covers the enlargement of approximately 11,600 feet of the Clark Dike between the New York, New Haven, and Hartford Railroad near Wethersfield Avenue and the Airport Road near the National Guard Hangar. This work is the beginning of construction which when completed will afford protection against floods of greater magnitude than the 1936 flood.

Detailed designs including contract plans and specifications are being made for the Definite Project dams at Union Village, Vt., Surry Mountain, N. H., and Knightville, Mass.

UNION VILLAGE DAM AND RESERVOIR.

The Union Village Dam is to be located just north of the town of Union Village, Orange County, Vt., on the Ompompanoosuc River, about four miles above its confluence with the Connecticut.

The dam will be a hydraulic-fill earth embankment, 160 feet high and 980 feet in length. It will have a top width of 20 feet and a maximum base width of 950 feet. A total of approximately 1,000,000 cubic yards of earth and 180,000 cubic yards of rock will be used to construct the embankment.

A flat crested, curved spillway, 370 feet long, constructed on rock on the right bank, is designed to discharge 52,000 cubic feet per second under a 13-foot surcharge. Its discharge will be carried around the dam proper in a wide channel to a point well below the toe of the dam, where it will rejoin the river.

A concrete-lined horseshoe shaped tunnel, 13 feet in diameter and 1,200 feet long, located in rock on the left bank, will provide reservoir control. Flow through the tunnel will be controlled by two caterpillar type gates operating in a vertical shaft located near the center of the tunnel. Machinery and other equipment necessary to operate the gates will be housed in an operating house directly above the gate shaft.

When completed, the dam will have a storage capacity of 30,200 acre-feet of water, equivalent to 4.5 inches of run-off over the drainage area of 126 square miles above the dam. The reservoir will have an area of about 600 acres at spillway elevation and will extend about four miles upstream.

SURRY MOUNTAIN DAM AND RESERVOIR.

The Surry Mountain Dam will be in Cheshire County, about five miles northwest of Keene, N. H., on the Ashuelot River, about 34 miles above its confluence with the Connecticut River.

The dam is to be a rolled-fill earth embankment, 1,680 feet long and 85 feet high. It will have a top width of 30 feet and an average base width of 500 feet. A total of approximately 740,000 cubic yards of earth and 160,000 cubic yards of rock will be required to construct the embankment.

An open side-channel spillway, 360 feet long, having a maximum capacity of 41,000 cubic feet per second under a 10-foot surcharge will be constructed on the right bank. Its discharge will be carried in a 30-foot wide channel to a point well below the toe of the dam, where it will rejoin the river.

A concrete-lined horseshoe type tunnel, 10 feet in diameter and 390 feet long, driven through rock in the right bank, will provide reservoir control. Flow through the tunnel will be controlled by two Broome gates operating in a vertical shaft located on the upstream side of the dam. Machinery and other equipment necessary to operate the gates will be housed in the operating house directly above the gate shaft.

When completed, the dam will have a storage capacity of 32,500 acre-feet of water, equivalent to 6.1 inches of run-off over the drainage area of 100 square miles above the dam. The reservoir will be three miles in length and have an area of about 970 acres at spillway elevation.

KNIGHTVILLE DAM AND RESERVOIR.

The Knightville Dam is to be located north of the town of Knightville, in Hampshire County, Mass., on the Westfield River, about 25 miles above its mouth.

It is proposed to construct a hydraulic-fill earth embankment with a height of 140 feet and a length of 1,000 feet. At the top it will be 20 feet wide with a maximum base width of 885 feet.

A concrete spillway is designed to pass 48,400 cubic feet of water per second into the spillway channel.

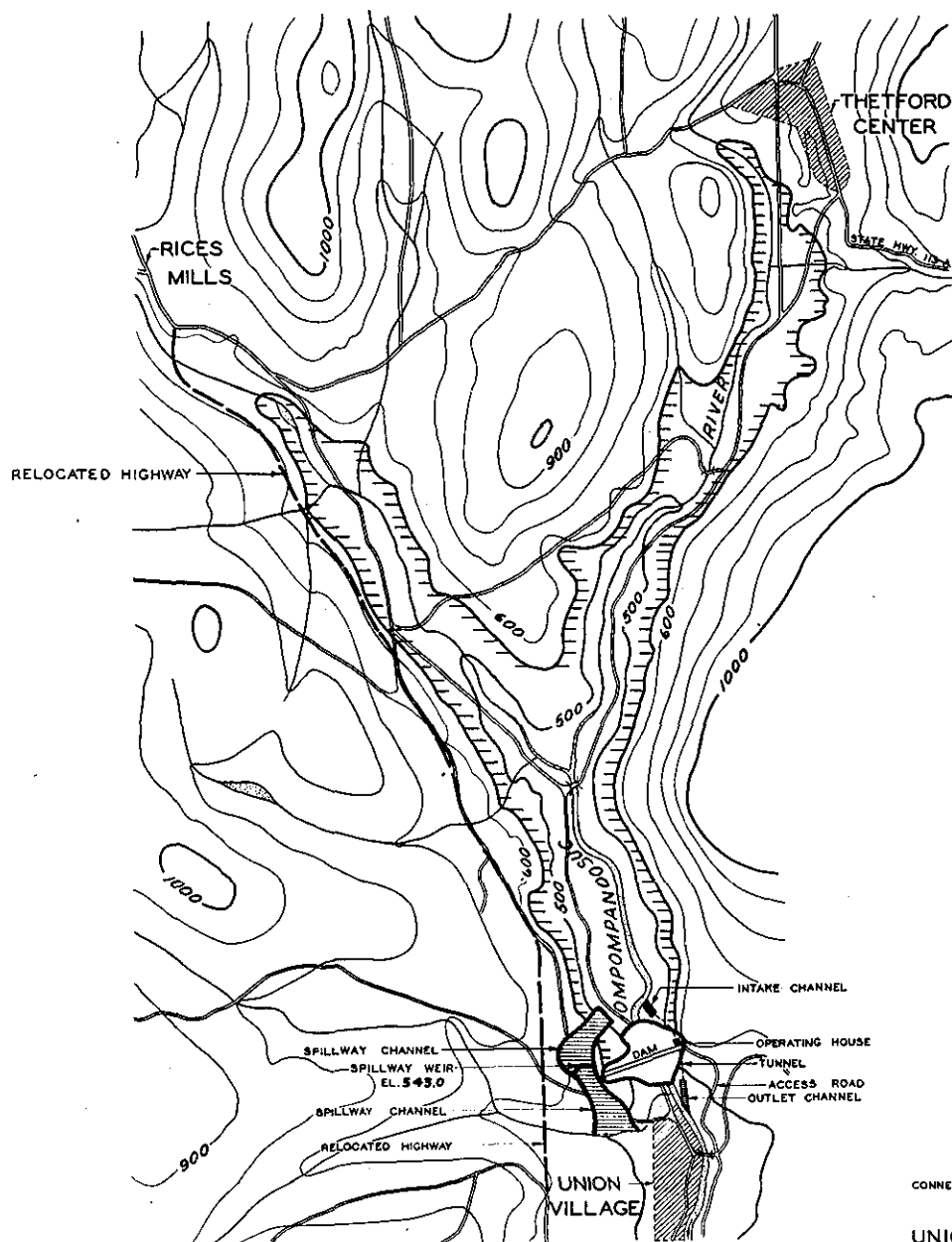
Flowage will pass through a tunnel, 850 feet long and 17.5 feet in diameter, excavated through rock in the right abutment. Two gates, electrically operated from an operating house on top of the concrete section of the dam, will control this flow.

It is estimated that it will take two years to build this dam and it will require the placing of about one million cubic yards of earth.

The reservoir will impound 39,300 acre-feet of water, equivalent to a run-off of 4.5 inches from the watershed of 164 square miles above the dam. The reservoir will have an area of about 860 acres and will extend about four miles upstream.



UNION VILLAGE, VERMONT
View of Dam Site from downstream



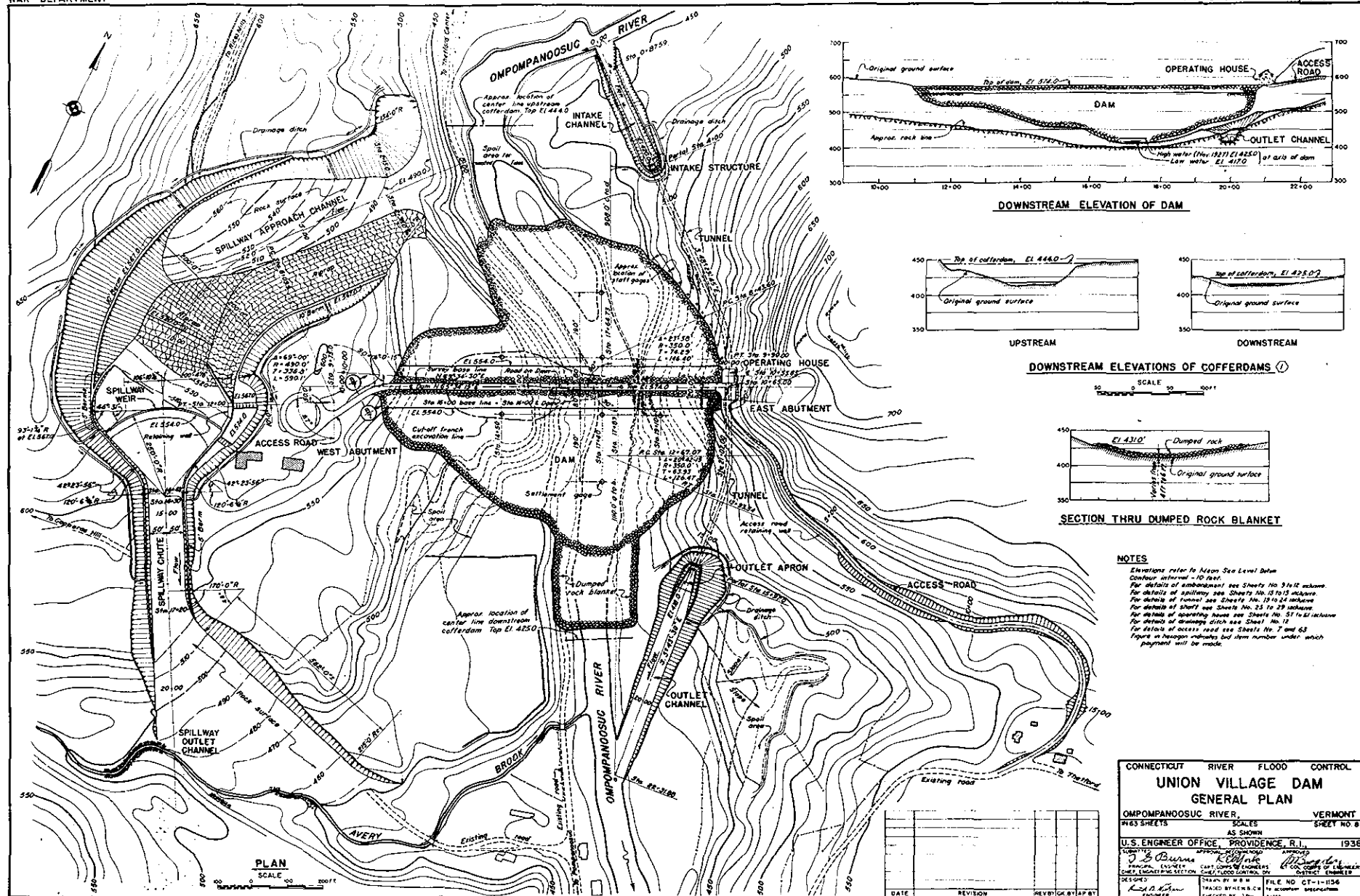
CONNECTICUT RIVER FLOOD CONTROL

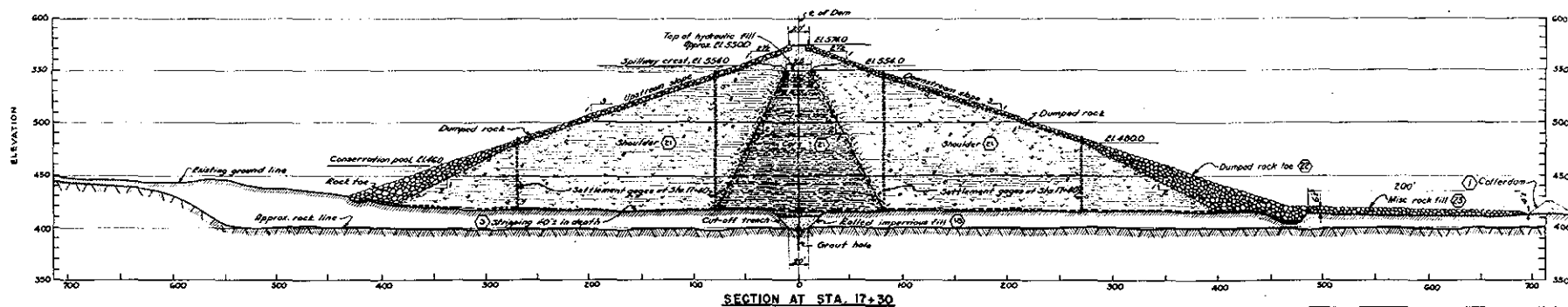
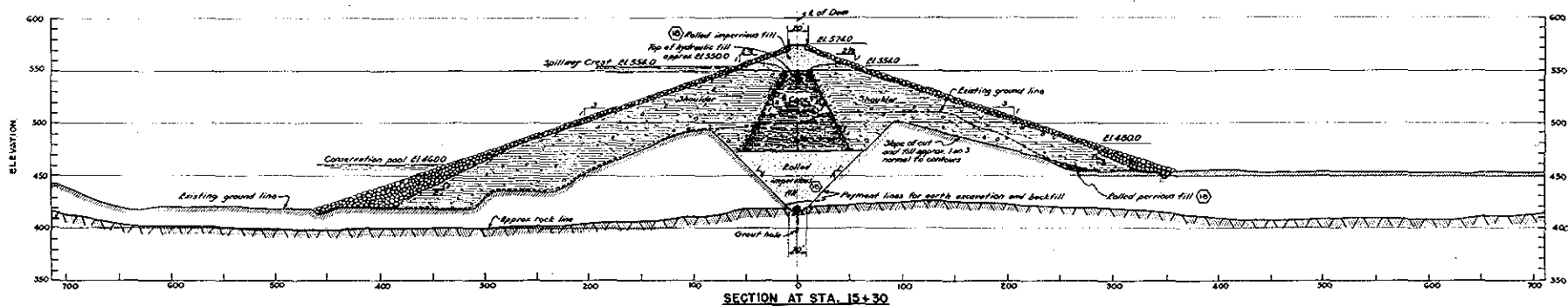
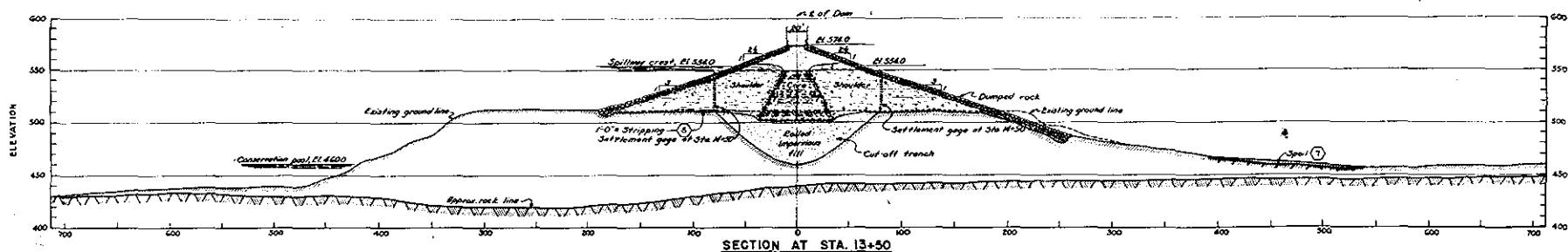
RESERVOIR MAP
UNION VILLAGE DAMOMPOMPANOSUC R., VERMONT
U.S. ENGINEER OFFICE
PROVIDENCE, R.I.SCALE
0 1/4 1/2 MI

IN 1 SHEET

SHEET NO. 1

CT-1-1089

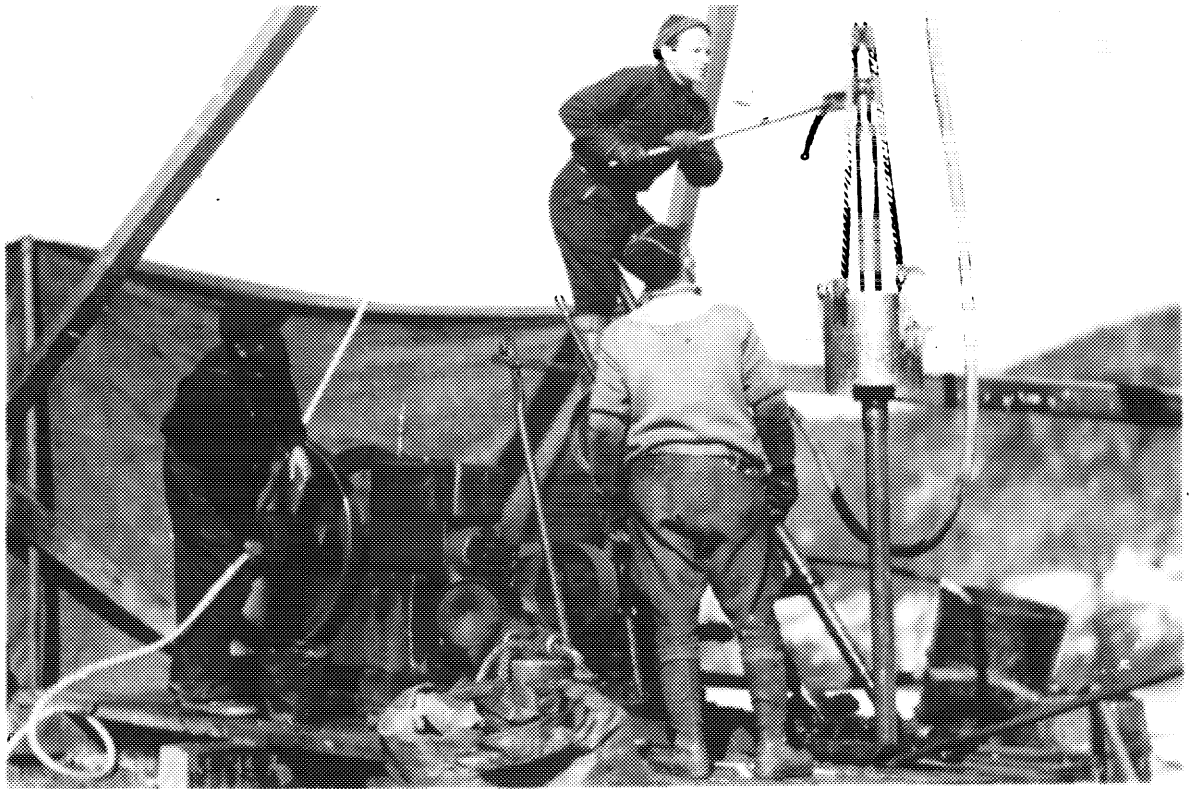




NOTES
For general notes applying to details
on this sheet see sheet No. 9

DATE	DESIGN	REVISION	BY	DATE

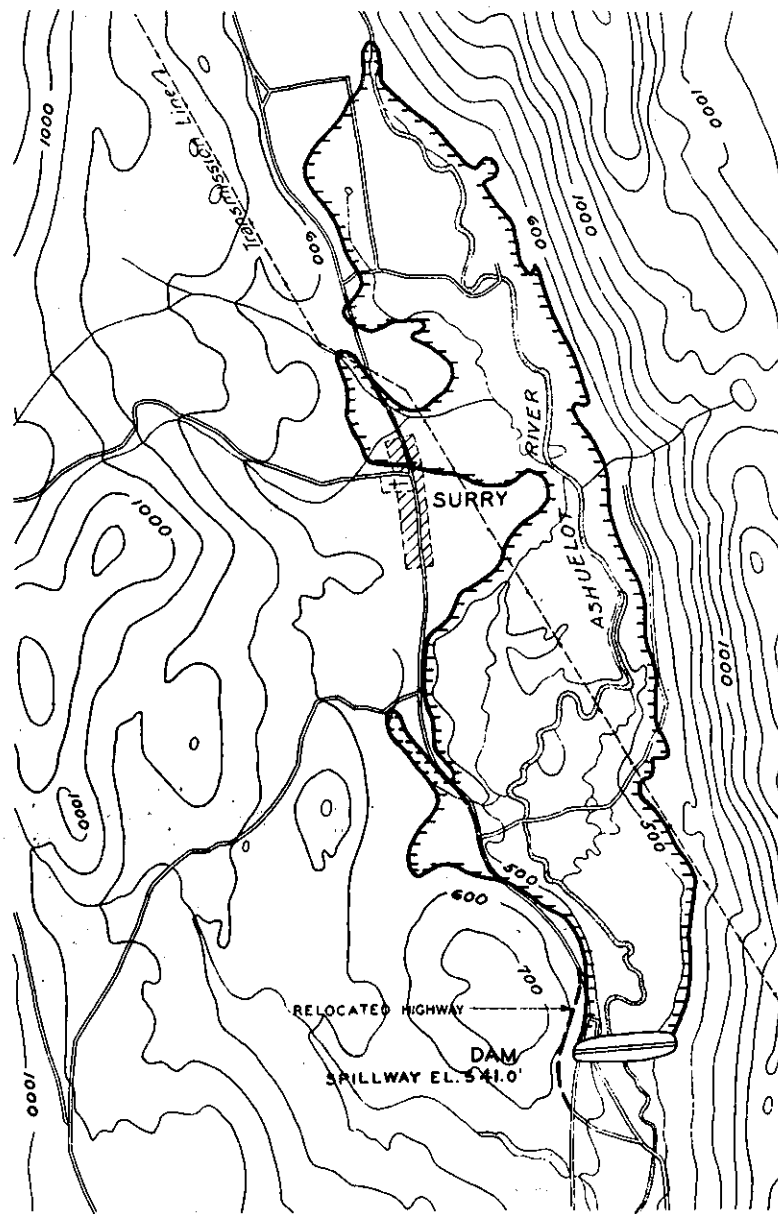
CONNECTICUT RIVER FLOOD CONTROL	
UNION VILLAGE DAM	
EMBANKMENT DETAILS NO. 2	
ONPOMPANOOSUC RIVER, VERMONT.	
163 SHEETS	SCALE AS SHOWN
U.S. ENGINEER OFFICE, PROVIDENCE, R.I.	1938
SUBMITTED: <i>[Signature]</i>	APPROVED: <i>[Signature]</i>
DESIGNED: <i>[Signature]</i>	CHECKED: <i>[Signature]</i>
DRAWN BY: <i>[Signature]</i>	FILE NO. 07-1-1150
ENGINEER: <i>[Signature]</i>	DATE: <i>[Signature]</i>



SURRY MOUNTAIN, NEW HAMPSHIRE. OVERBURDEN DRILLING. WASHING OUT CASING IN COMPACT MATERIAL.



SURRY MOUNTAIN, NEW HAMPSHIRE. SHOWING DRILL RIG ON RIGHT ABUTMENT CENTER LINE OF PROPOSED DAM



CONNECTICUT RIVER FLOOD CONTROL
RESERVOIR MAP
SURRY MOUNTAIN DAM.

ASHUELOT RIVER, NEW HAMPSHIRE
U.S. ENGINEER OFFICE
PROVIDENCE, R. I.

SCALE
0 1/2 MI

IN 1 SHEET

SHEET NO. 1

GT-1-1033A

